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Determination of Patterns of Behavior Through Controlled Early Experience

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DETERMINATION OF PATTERNS OF BEHAVIOR
THROUGH CONTROLLED EARLY EXPERIENCE

by
Betty Lou Penhale

A Thesis Submitted to the Faculty of the Graduate School
of Loyola University in Partial Fulfillment of
the Requirements for the Degree of
Master of Arts

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LIFE

Betty Lou Penhale was born in Chicago, Illinois, June 27, 1936.

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CHAPTER I

INTRODUCTION

The psychoanalytic emphasis upon the importance of early experience in the formation of personality (Fredericson, 1951; Freud, 1933; Mullahy, 1948), and the recent stress upon learning as the basic process in behavior development at complex levels (Hebb, 1949; Hilgard, 1948), both suggest that the organism's earliest relationships can influence later behavior. Considerable impetus to work in this area has been given by the stimulating thoughts of K. Z. Lorenz (1935), who formulated a conceptual model of acquisition of behavior which he called "Prägung" (imprinting). Work in this area (Lorenz, 1935; Ramsey, 1951; Schaefer, 1958) lends credence to the psychoanalytic practice that has done much to stir interest in and gain acceptance for the hypothesis that early traumatic experience is an essential determinant of adult neurosis. (Eysench, 1951) Although this hypothesis is suggestively supported by numerous case histories, actual controlled experimental evidence is limited.

The purpose of this study was to test experimentally

whether an intense stressful situation experienced during infancy would have a measurable effect on adult behavior of rats.

If it is true that a general law underlies the early experience-later effects model, then traces of such a law would be observable at all stages of the phylo-genetic scale. On this basis it was felt that findings with lower animals would be of more than specific interest and applicability.

CHAPTER II

REVIEW OF THE LITERATURE

It has always been felt that human beings learn a great deal during infancy and childhood and that the results of this learning often continues to affect behavior throughout the remainder of the life span. During the past two thousand years, writers compiled anecdotes and life histories of various animal species on this issue, but not until the emergence of comparative psychology in the closing years of the nineteenth century did the subject of behavioral development attract serious scientific interest. Among the earliest American workers to deal with this problem was Small, who in 1899, published an article on the albino rat as an useful subject of psychological investigations. (Small, 1899) Small's account included a section dealing with behavior in infancy and adolescence. Eight years later Yerkes' book, The Dancing Mouse (1907) appeared, and dealt, among other things, with ontogenetic aspects of behavior. The importance of early experience in relation to adult behavior has also received much emphasis in Freudian Theory (Freud,

1933). Freud has stressed the postulate that the early experiences in the life of a child leaves an experiential residue which effects later behavior. These early experiences, such as sucking, weaning, etc., were described as having special importance in the shaping of the adult personality. However, Freudian theory arose from clinical observations, not experimental evidence, and such observations do not in themselves contribute controlled empirical findings on the problem of infantile experiences in relation to adult personality. There exists a wide range of data and informal observations to serve as evidence that the experiences of childhood are related to adult behavior; what is lacking is any general agreement upon the nature of the relationship.

In the field of comparative psychology many have been able to demonstrate that infantile experiences are an important determinant of later behavior. In particular, the work of J. McV. Hunt and D. O. Hebb clearly demonstrates that adult feeding patterns may be altered by certain infantile experiences (controlled food schedules), and that the manipulation of the organism's early environment, insofar as restricting it, or broadening it, influences later behavioral patterns.

Weininger (1953, 1956), and Weininger, Mc Clelland, and Arima (1954) were concerned with the gentling of rats during

infancy and its effects on weight gain. It was argued that the tactile stimulation which the handled animals received during gentling was the crucial variable. Further investigation by McClelland (1956) provided support for the thesis that tactile stimulation during handling in early life contributes significantly to subsequent weight gain in albino rats.

Bernstein found that handling of rats in infancy improves learning ability in mazes during adulthood (Bernstein, 1952). In connection with handling, a series of observations by Greenman and Duhring at the Wistar Institute in Philadelphia in 1931, has indicated the effects of individual attention, shown by handling and petting, on the growth and survival of the albino rat. Greenman and Duhring found that more than 75 per cent of the handled albino rats survived an operation for the removal of the parathyroid gland, whereas less than 15 per cent of the unhandled animals survived such an operation. These investigators further suggest that the more the albino rat is handled and petted, the better it seems to thrive in the laboratory situation. These observations of Weininger together with those of Greenman and Duhring suggest that early experience of handling by the experimenter may influence a number of variables related to the later vitality of the rat. Consequently, the variables of growth, activity, and effects of immobility, action, food and water deprivation were then

investigated by Weininger (1956). In this study he found that his stressed rats, when in an open-field ventured significantly close to the brilliantly-lighted center of the open-field setup, thus showing more of a tendency to ignore the natural habit of their species to cling to walls and to avoid light. Regarding the rats that were gentled he proposed one theory, that a decrease in the emotional reactivity of the animals to ordinary laboratory stimuli may have been instrumental in increasing body weight.

Scott (1955) found no significant differences between the amount of weight gained by gentled and ignored rats. After seventy-four days of age, he found that both the gentled and ignored rats attained the same average weight. His study was planned to test the dependability of and to extend the studies of Weininger and Bernstein. The extension derived from the hypothesis that the adult differences observed between rats gentled and rats ignored could be exaggerated by increasing the range of the independent variable during infancy. Assuming that this independent variable is autonomic or emotional stress, it was presumed that the continuum from gentling to ignoring could be extended by adding the experience of repeated electric shock. Scott believed it was just possible that the effects on weight reported by Weininger and Bernstein were artifacts of a developmental magnification of small group differences present

at the beginning of the experiment yet favoring the hypothesis. It was an appreciable covariance of initial and later weights which led to Scott's choice of "per cent of original weight gained" as the most appropriate way to indicate weight changes. Scott failed to confirm the studies of Weininger and Bernstein, and attributed these findings to the differences in strains of rats, (Sprague Dawley vs Wistar) and the fact that Scott handled his ignored rats when they were weighed. He found it impossible to draw definite conclusions. The fact that the results obtained from the stress situation tend to deny the hypothesis that homeostatic efficiency is altered by such infantile experiences as gentling, ignoring, and shocking may mean that this is the wrong place to look for effects of infantile experience. The fact that the only significant effects of these experiences concerned the greater inhibitory effects of shock on activity for those animals that had suffered shock in infancy may mean that we should look for effects as "meanings of situations" derived from autonomic responses conditioned to perceptual cues or to the feedback from an organism's own responses.

Reid, in an unpublished study conducted at the University of Mississippi in 1944, investigated infantile perturbation as an element in the genesis of abnormal behavior in the rat. (Reid, 1944). Fifty-nine rats were subjected daily from the twentieth through the forty-fifth day of age to the following stimuli;

intense auditory stimulation, rapid rotation, electric shock, and tossing in the air and catching. After reaching an average of one hundred days of age, the animals were given a series of tests to determine the possible effects of early perturbation. It was found that the experimentals showed a more varied or non-directed pattern of behavior when presented with an insolvable discrimination problem and were more susceptible to audiogenic seizures than the controls. Failure to use appropriate control techniques prevented the author from making adequate generalizations.

Eriksen et. al. (1948) found that rats subjected to a series of electroconvulsive shocks between the age of twenty and thirty days suffered permanent impairment of maze-running ability. The animals were inferior to a control group in performance on the multiple-T-maze. Hall and Whiteman (1952) have recently reported that subsection of infant mice to intense stimulation resulted in emotional instability in later life. On the other hand, Griffith (1952), in his study on the effects of intense stimulation on rats before weaning, showed negative results. He subjected fifty-eight albino rats to one of the following stimuli once daily during the first nine days of life and twice until the fifty-seventh day of age; intense auditory stimulation, rapid rotation, extremes of environmental temperature, and shock on an electric grid. Beginning at sixty days

of age a group of tests was instituted to determine whether the intense stimulation experienced during infancy would measurably affect adult behavior. Learning ability was tested by using the Warner-Warner maze and a modified Lashley discrimination apparatus; emotionality was measured using the Hall open-field test; and susceptibility to shock-induced convulsions was investigated by using a 110-V electric bell. Since no significant differences were found between his experimental and control animals, it was concluded that subjection to intense stimulation during early infancy does not measurably affect adult behavior in the rat.

From the results of these studies (Hall, 1934, 1952; Scott, 1955; Porter, 1948; Griffiths, 1952) it would appear a reasonable hypothesis that effects of infantile experiences on mature animals' behavior are related to the intensity of the early experiences, the particular period during infancy when the experiences are initiated, the amount of time elapsing between the experiences and the tests and the type of tests used during adulthood to detect possible affects of early stimulation.

In contrast to Griffiths (1952) and Porter, Stone and Eriksen (1948), Hall and Whiteman (1952), working with mice, have concluded that intense stimulation during infancy is related to emotional instability during adulthood. These investigators subjected infant mice to loud, high-frequency sound for two-min.

periods and tested them later in life for emotional stability. At thirty to forty days of age, the mice were tested in an open-field temperament test; at seventy to eighty days of age the subjects were given the stove-pipe test for emotional stability; and at 100 to 110 days of age the mice were retested in the open-field test. The authors reported that the experimentals were significantly more fearful than the controls on the first open-field test. On the stove-pipe test, however, the investigators found that "not all mice were affected equally by the sound. In fact, in only six cases is it possible to say that infantile experience influenced their adjustment to the stove-pipe. The other fifteen behaved normally" (Hall, 1952; p.66). Hall and Whiteman also showed that during the second open-field test of emotionality, temperament differences between the experimentals and controls were not significant at the five per cent level of confidence. It would appear that these results hardly justify the authors' generalization that their study has demonstrated that animals exposed to high-frequency sound in early infancy are more emotionally unstable than controls that had not received any stimulation.

The most recent increase of interest in the effects of early life experiences upon the behavior of adult animals is traceable to theories that stress the importance of perceptual learning in infancy upon subsequent performance in tests of

learning, and that an animals performance on special 'intelligence tests' is directly related to certain kinds of experience in infancy. A leader in this field is D. O. Hebb, whose book, The Organization of Behavior (1949) has been directly or indirectly responsible for a number of experiments reported in psychological journals during the last five or six years. In brief, his theory predicts that animals that have had a large amount of perceptual experience early in life will prove better learners than others deprived of such experience. Further, it is predicted that the magnitude of this facilitative effect is, within limits, inversely related to the age at which perceptual experience is gained.

Evidence for this view has been obtained largely by varying the environment in which the animal matured. Rats reared from twenty-one to fifty-one days in a small room and not in cages were found to be superior in maze learning to other animals that had been reared individually in mesh cages which were periodically moved from one position to another in this large room. A third group was kept in enclosed activity wheels and a fourth group in enclosed stove-pipe cages. Rats in the first two groups performed significantly better on the Hebb-Williams maze than did the latter two groups. It was concluded that visual experience facilitates adult learning ability (Hymovitch, 1952). A further study confirmed the preceeding results and added the

finding that having early access to pieces of apparatus somewhat similar to parts of the Hebb-Williams maze further increased learning scores on that particular test (Forgays, 1952).

In an experiment by Hebb (1937), two groups of animals were blinded; one as soon as the eyes were opened, the other as soon as they reached maturity. In order to determine any difference which might exist due to the longer period of visual experience in the late-blinded group, the performance of the two groups was compared by means of the variable-pattern T-maze. He found that the late-blinded group was reliably superior in performance in the test situation.

Bingham and Griffiths (1952) repeated a portion of Hebb's work in greater detail with a somewhat larger group of animals under more rigidly controlled conditions. The purpose of the study was to determine whether rearing animals in very different environments during infancy would measurably effect learning, emotionality, or susceptibility to sound-induced convulsions during adulthood. Results of the experiment indicated that rats reared in wider and richer environments of the experimental rooms were superior in maze-learning ability to animals reared in laboratory cages or 'squeeze' boxes. No difference in temperament, discrimination, or susceptibility to sound-induced seizures during adulthood could be traced to differential early environments. It was concluded that for the rat, early

environments, characterized as wide, have an influence on certain forms of adult behavior such as maze learning, but that the particular factors constituting the richness of the wide environments did not seem related to the superior maze performance of experimentals over controls. It was evident that all forms of adult behavior were not measurably affected by the differential early environments utilized in this study.

Hebb's experiments were repeated and elaborated with much larger samples of rats and with more adequate control by Hymovitch (1952). He confirmed the earlier work by finding that rats reared in a complex environment (free environment) were significantly superior in problem-solving ability, as measured by the Hebb-Williams test (1946), to animals reared under conditions which severely limited their total experience (restricted environment). Hymovitch employed as the complex environment a large box containing a number of 'playthings' (simple wooden and metal structures) to afford the rats a variety of experience. In addition, he also placed in this structure small mesh cages in which other rats were reared and which were removed occasionally from place to place, both inside and outside the box. As adults, these mesh-caged rats were unexpectedly good at problem-solving behavior; in fact, they were indistinguishable in this regard from those animals that were given run of the box during the same period of time. Hymovitch determined

that the differential effects of varied early environments on adult rats did not result from unequal opportunity for motor experience or from differential motivation of the various groups. Forgays and Forgays (1952) attempt to explain this in terms of differential opportunity for visual experience and learning during rearing.

Investigators of the effects of rearing rats (Hebb, 1937) and also chimpanzees (Harlow, 1949; Riesen, 1947) in darkness have concluded that early visual experience is required for the development of efficient visual responsiveness.

Studies by J. McV. Hunt (1941; 1947) show that rats suffering from feeding frustration during infancy tended to display more hoarding behavior after periods of starvation at maturity than rats that had not been so deprived during early life. A similar phenomenon occurred as a result of a lack of satisfaction of sucking needs in puppies (Levy, 1947). In later life these puppies displayed a 'perverted' type of continual sucking and oral behavior.

Fredericson (1951) investigated the effects of infantile experience on a different type of behavior, namely competition. Hungry infant mice were trained to compete over food for a few days shortly after weaning. Following this experience they were allowed to grow into adulthood without having to compete. It was then thought that this experience in competition during

infancy would cause them to fight over food on a retest many weeks later when they were sexually mature, not being hungry at this time. The littermates of the experimental Ss were raised without competitive experience during infancy. This control group did not compete for food when tested as adults. It was believed that these results support theories of personality which emphasize the importance of infantile experience.

Observations and theories of Konrad Lorenz (1935) and other European biologists who examined the effects of early social stimulation upon the adult behavior of various species of birds have shown that certain responses of some birds to their partners may be elicited in early life by human beings or specific moving objects. Lorenz maintains that there is an innate organization (Angeborenes Schema) for these responses. Once established, however, they can be elicited only by the original releaser (Auslöser), whether it be parent bird, moving object, or man. The responses can not be established for the first time in later life.

Suggesting possible answers to the question of how early experience can affect later behavior is meant to imply neither that the conclusions are mutually independent, nor that they are together exhaustive. Rather, they should appear as currents of thought along which research in this area has progressed. It can be said that the longitudinal approach to the study of

animal life is obviously more beset with methodological problems than studies concerned with only one portion of the life span. Experimental control in this area is more difficult to realize, because the animals, by the very nature of the problem, are exposed to numerous variables, some of which may not yet be recognized as capable of isolation. These difficulties, however, are more than offset by the general interest and wide significance of the problems that may be studied.

CHAPTER III

METHOD

Subjects

Thirty-three albino rats of the Sprague Dawley strain were used as subjects, randomly sorted by litter, into three groups; one group of eleven rats as Control I, one group of ten rats as Control II, and one group of twelve rats as the Experimentals. All subjects were weaned at twenty-one days of age and brought to the laboratory. The experiment began when the animals reached the ages of:

Control I . . .	26-34 days old, mean age 29.5 days
Control II.x. .	26-34 days old, mean age 29.5 days
Experimental. .	26.34 days old, mean age 29.2 days

Experimental Design

The twelve rats of the experimental group experienced a "stressful" situation by being dropped by hand from the height of four feet into a galvanized pail, twelve inches in diameter by twelve inches high, with a water level of six and one half

inches. The water temperature was a constant seventy-eight degrees. The experimental group was left in the pail for sixty minutes (one hour) during which time they were allowed free swimming or floating activity in the pail, and a continuous record was kept of their behavior.

The eleven rats of the Control I group were dropped in the same pail and left there for sixty seconds (one minute).

The ten rats of the Control II group were not exposed to the types of mild and intense stimulation experienced by the other two groups, and served as the control group for this experiment.

All the animals then remained undisturbed, except for feeding, in individual metal living cages, until they reached seventy-two days of age.

Apparatus

A modified Hebb-Williams (1946) maze was used as a closed-field apparatus to test timidity and open field behavior. The apparatus consisted of a box mounted on a table with an entrance alley and food compartment at opposite corners of an open field. The details of the apparatus are shown in Figure 1.

The floor of the box was made of 1/4 inch wire mesh, 1 1/2 inches from the table top, with a uniform layer of crushed absorbent rock between the wire and table top. The open-field

Fig. 1--The Modified Hebb-Williams Open-field Maze in which the animals were tested. (see following page)



area was covered with 1/4 inch wire also. The walls were painted grey and made from stock 36 X 36 X 6 inch dressed lumber. There were 36, six-inch squares outlined in copper wire on the floor of the field. These served to define error zones.

Procedure

Each animal at seventy-two days of age was placed in the open-field apparatus for a total of thirty-three trials over a period of ten days. The trial schedule is shown in Table 1. For each trial the animal was placed in the starting box, the door was opened and the animal entered the open-field. As soon as Ss did so, the door of the starting box was closed and the goal box door opened.¹ The Ss was allowed to roam about in the field until entering the goal box. When in the goal box, the door behind the Ss was closed. Rockland rat pellets, the same as used for feeding in the home cages, were used as a reward. During the days of the experiment, Ss were only fed in this goal box for one minute after each trial, and for five minutes after the final trial for the day. The time taken to leave the starting box and the time taken to cross the field was recorded.

During the time in the field, the following behavior was

¹ Opening and closing of the boxes was affected by distant control by means of mechanical devices, which permitted the experimenter to stay out of view of the animal.

Table I

The schedule of trials for the 10 consecutive days

DAYS	NO. of TRIALS
First day	3
Second day	5
Third day	5
Fourth day	5
Fifth day	2
Sixth day	2
Seventh day	2
Eighth day	2
Nineth day	2
Tenth day	5

Total trials 33

recorded:

1. Defecations.
2. Number of zones entered determined by the copper wire squares.
3. The kind of crossing (wall seeking or direct crossing from start box to goal box).
4. Oscillations before entering goal box..yes or no.
5. Oscillations before entering goal box..number of times.
6. The time spent in the start box before entering the field.
7. The time spent in the field.
8. Number of explorations (determined by the number of times each animal pauses and lifts forepaws and front part of body from the wire floor or clings to wire mesh covering with forepaws). Each such movement denoted one exploration.

There was no training period before the experiment began. The Ss were not to learn before hand where the food was to be obtained since the first leaving of the start box was one of the measures used; also Ss did not establish the habit of eating out of the goal box until the experiment was in progress. A tabled outline of the experiment is shown in Table II.

Table II
Outline of the Experiment

GROUP	total no.	no. of animals	stress age (days)	test age	type of behavior observed
EXPERIMENTAL	12	3	26	72	1. Defecations 2. Kind of crossing 3. Zones entered 4. Oscillations yes/no 5. Oscillations number 6. Time spent in start box 7. Time spent in field 8. Explorations
		0	27	72	
		4	28	72	
		3	31	72	
		2	34	72	
CONTROL II	10	1	26	72	
		2	27	72	
		2	28	72	
		3	31	72	
		2	34	72	
CONTROL I	11	1	26	72	
		2	27	72	
		3	28	72	
		3	31	72	
		2	34	72	

CHAPTER IV

RESULTS

Examination of the latency measures, Figure 2, shows the mean time during the 33 trials spent in the open-field to be 117.02 seconds for the Experimental group, 81.02 seconds for the Control I group, and 60.9 seconds for the Control II group. Figure 3 is a cumulative record of these time measures over the 33 trials.

Since the time spent in the open field correlates highly with mode of crossing the open field (i.e. direct crossing using the shortest possible path, or indirect crossing, seeking the wall and moving back and forth within the field), a qualitative measure of the mode of crossing was recorded for each of the animals. Figure 4 gives the mean of the indirect crossings for the 3 groups. It appears that the Controls II made the least number of indirect crossings, followed by Controls I and then by the Experimentals. In other words, the Experimentals spent the most amount of time in the open field. These differences between the groups (see Fig. 5) are plotted in 3-trial blocks for the 33 trials and are significant at $p .05$ as determined by the Friedman two-way analysis of variance test,

**Fig. 2--Mean Time Spent in the Open-field Apparatus
During 33 Trials for 3 Groups of Animals.**

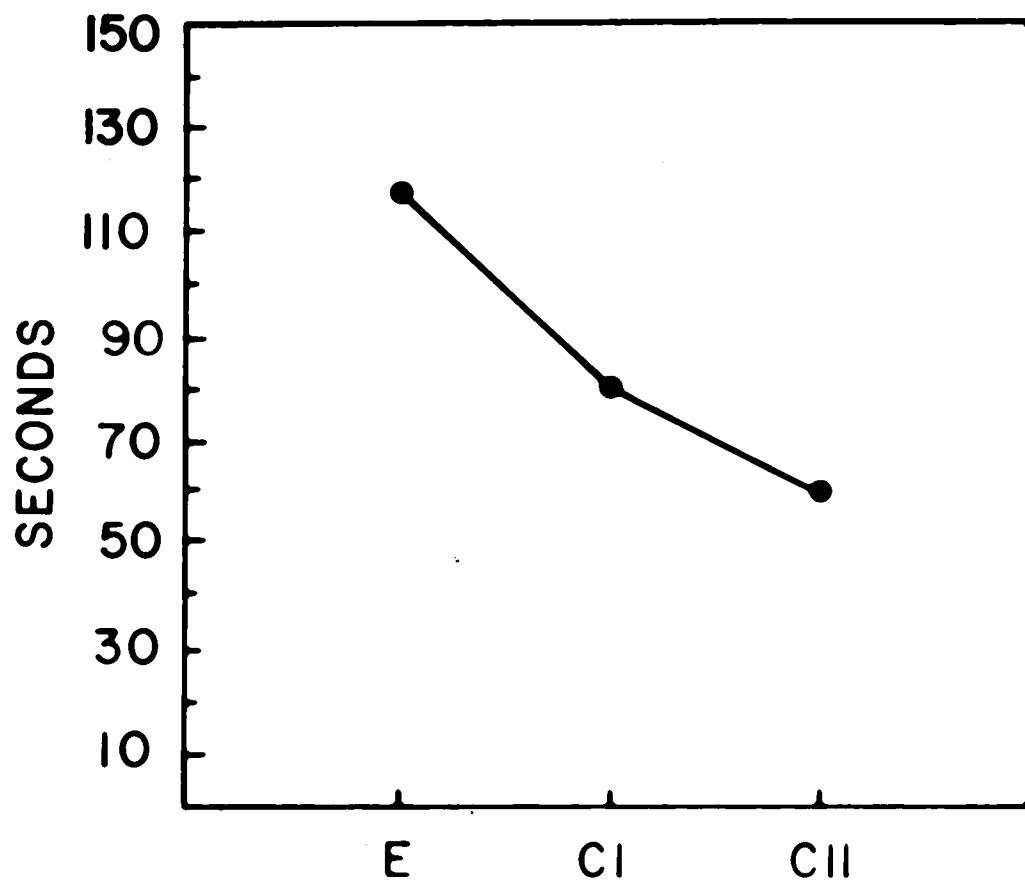


Fig. 3--Cumulative Time (1/100) Spent in the Open-field Apparatus During 33 Trials for 3 Groups of Animals.

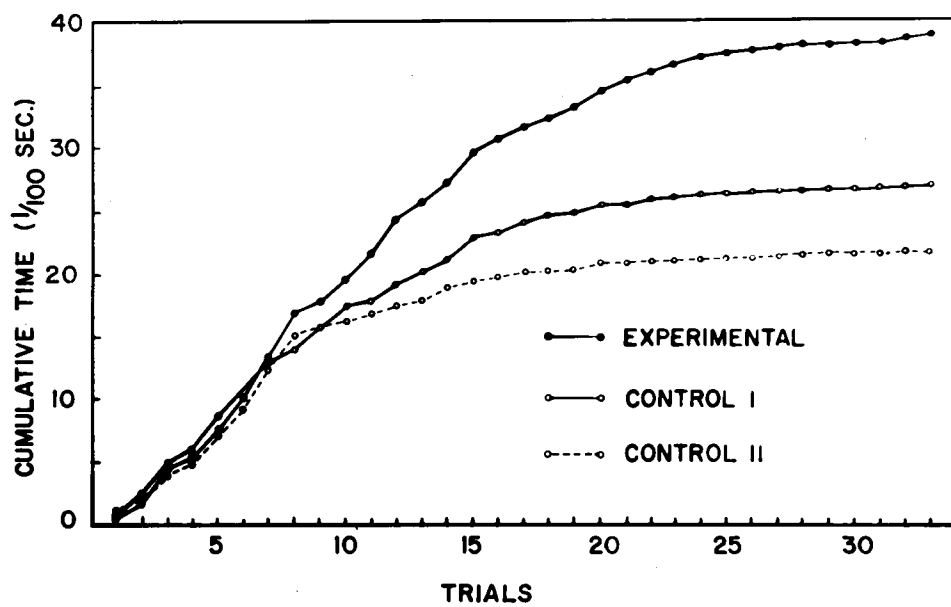


Fig. 4--Mean Number of Indirect Crossings in a Modified Hebb-Williams Maze for 3 Groups of Animals.

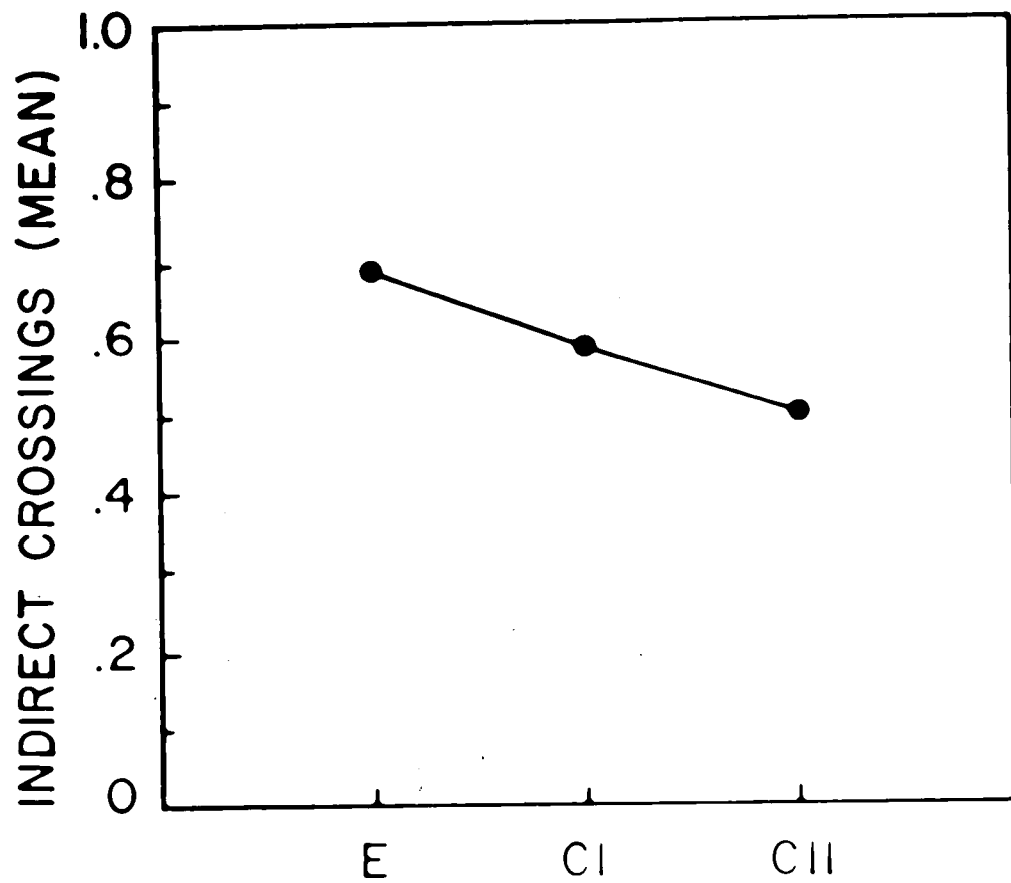
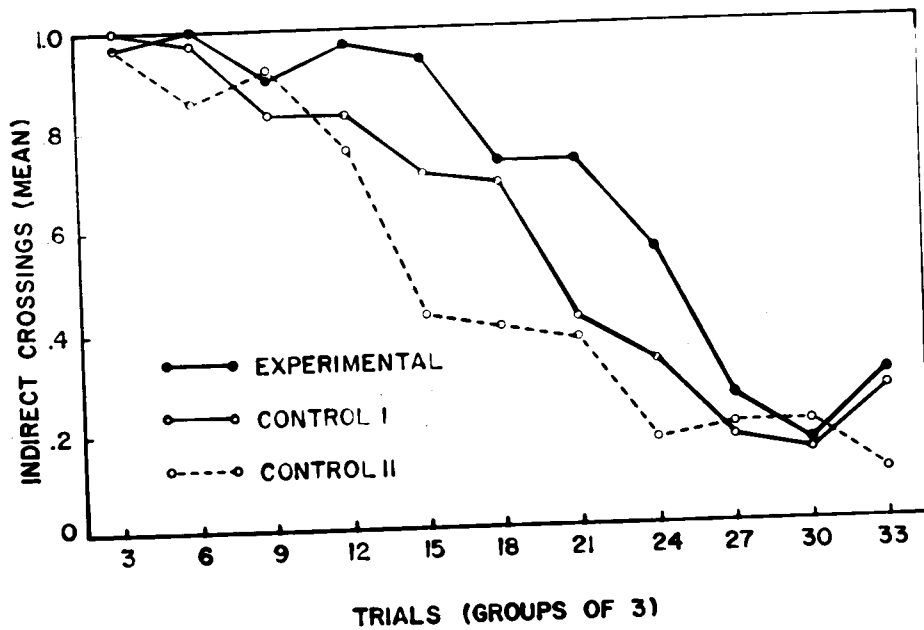


Fig. 5--Mean Number of Indirect Crossings in a Modified Hebb-Williams Maze for 33 Trials in 3-Trial Blocks for 3 Groups of Animals.



a non-parametric test which assumes that the ranking of each concurrent trial score for the groups should vary randomly. Figure 6, also of indirect crossings, shows a cumulative record for the 3 groups over the 33 trials.

An arbitrary criterion of successful mastery of the maze had been set up to be three direct crossings of the open field from the start box to the end box. This criterion was then reached first by the Controls I, second by the Controls II, and last by the Experimentals (see Figure 7). This observation verifies and is not independent of the mode of crossing as described in Figures 4, 5, and 6 above. The inversion of the Controls II and I (the only inversion of the order of scoring in this study) is interesting and will be dealt with in the discussion. The data, on number of trials to mastery, were treated with a Mann-Whitney U-test, between the two independent samples of the Experimental and Control I groups only, using the criterion as a speed of learning. A significance of $0.002 > p < 0.02$ was found, therefore showing the number of trials to criterion in the stressed experimental group significantly different than the Control I group and would probably indicate the effects of an infantile experience.

Another recorded measure of behavior was oscillations. By "oscillations" are meant the non-direct, hesitant, leaving of the start box or entering of the end box. While this

Fig. 6--Cumulative Record of Indirect Crossings for 33
Trials in a Modified Hebb-Williams Maze for 3 Groups of Animals.

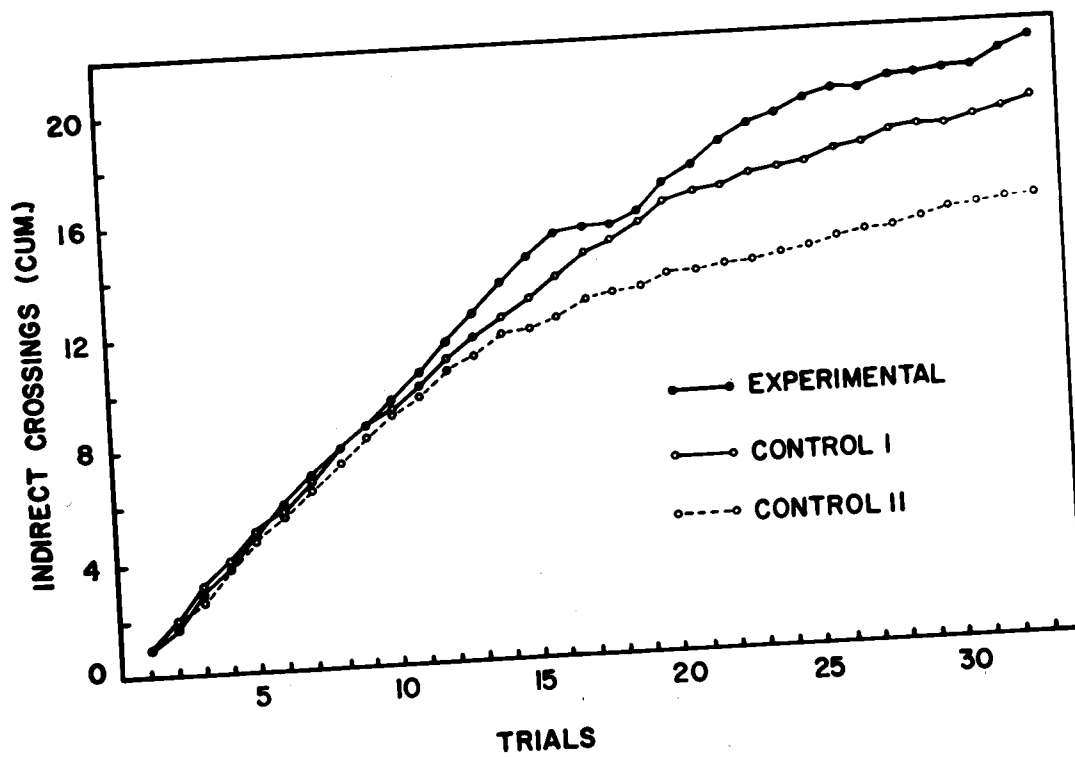
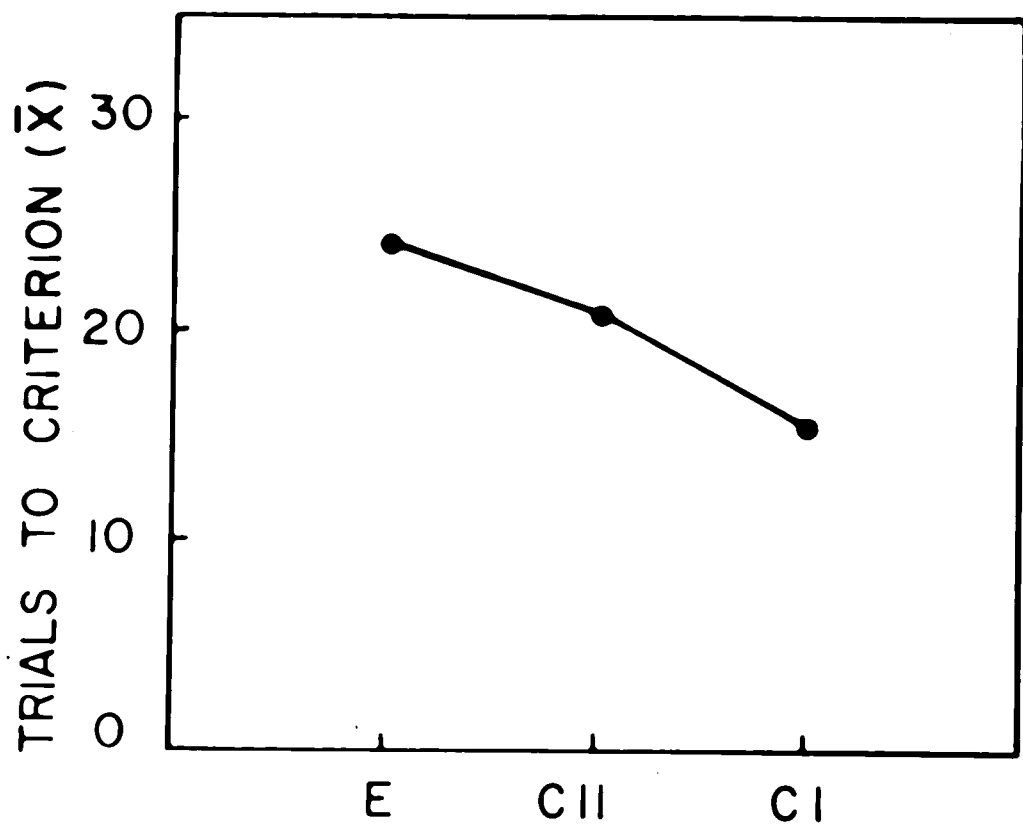


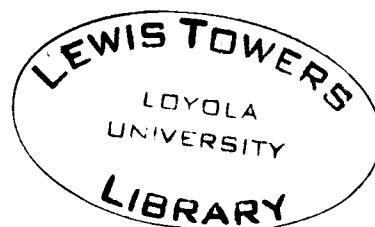
Fig. 7--Mean Number of Trials Taken to Reach a Criterion
for 3 Groups of Animals.



measure involves some degree of subjectivity, it is apparent to anyone who has seen these animals behave that the agreement among experimenters as to whether a rat leaves the box within a fraction of a second or with great hesitation over a period of up to many minutes is very high. Figure 8 illustrates the mean number of oscillations for each of the three groups, the Experimental group having a mean of 35.5 incidents of oscillation for each animal, the Control I group with a mean of 12.5, and the Control II group with a mean of 8.98. A χ^2 was computed from a Median Test on the data between the Experimental group and the Control II group and gave a significant $p < 0.02$. Fig. 9 shows the total distribution of the three groups over the 33 trials. An evaluation of these results made by a χ^2_r test gives a significant $p < 0.001$, thus indicating a high consistency of performance.

Mean oscillation incidence, Figure 10, determined by the occurring or non-occurring of oscillatory behavior of the Ss per trial for each group, also follows the trend of differences between groups and shows a greater mean incidence for the Experimental group. Figure 11 gives the incidence of oscillation per trial for each group over the 33 trial period and shows that after the 27th trial the two Control groups drop almost or completely to zero incidence of oscillations whereas the Experimental group continues. A χ^2_r was computed on the data and a

Fig. 8--Mean Number of Oscillations Made by 3 Groups of Animals.



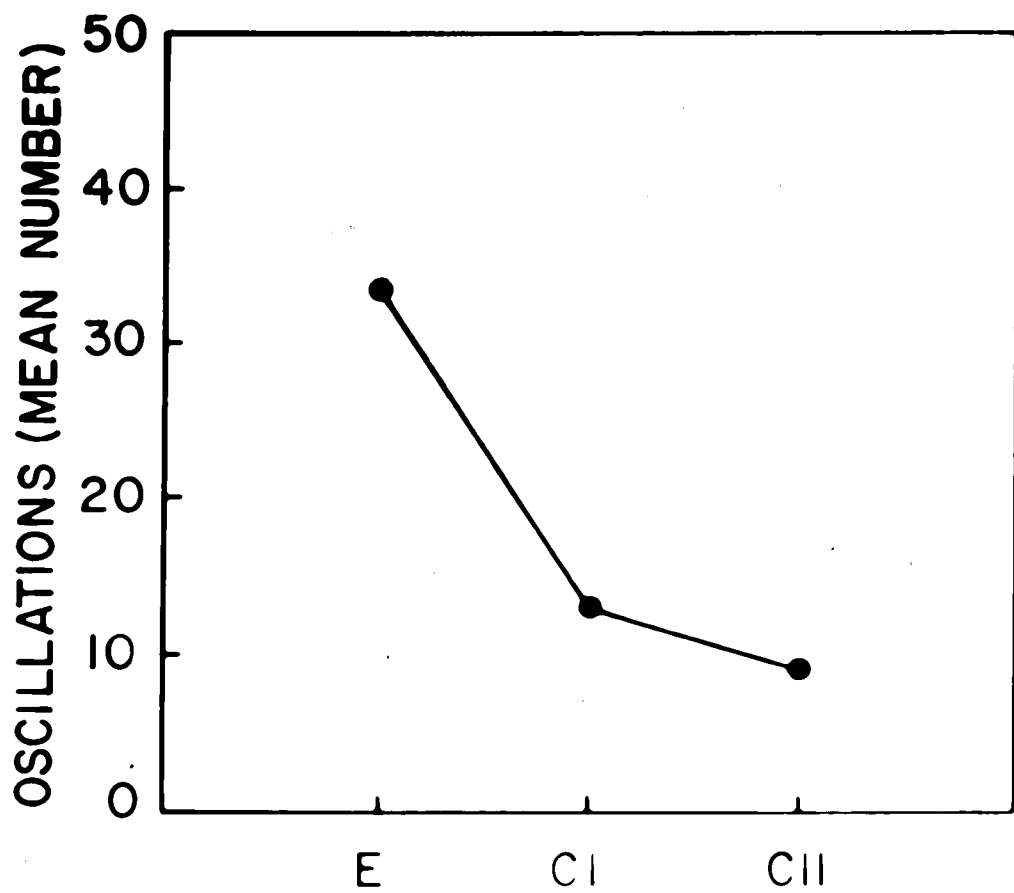


Fig. 9--Mean Number of Oscillations Per Trial for 33 Trials for 3 Groups of Animals.

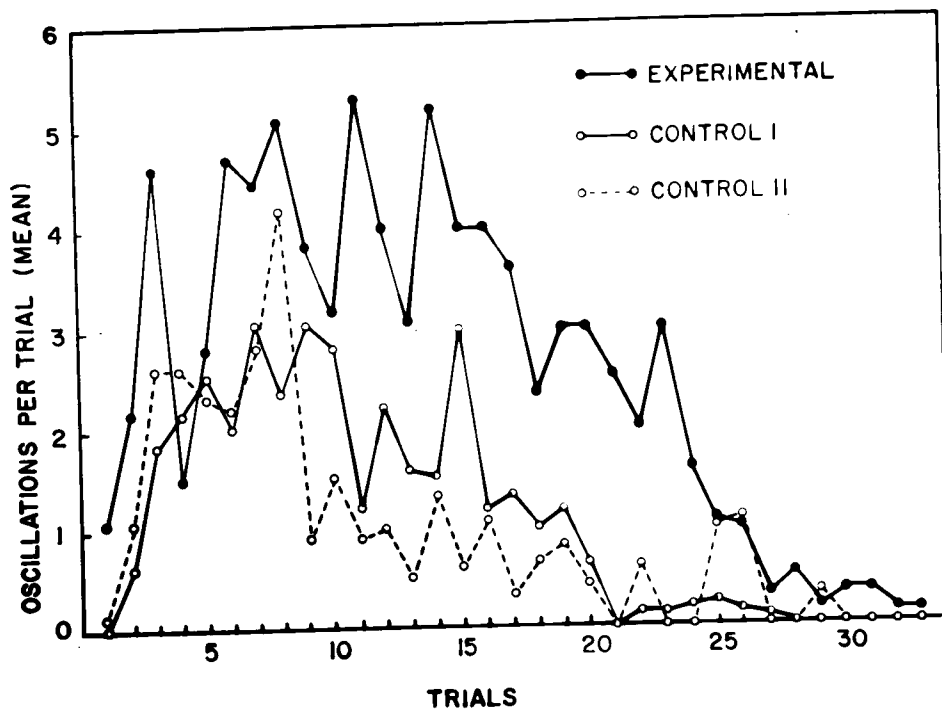


Fig. 10--Mean Number of Oscillation Incidence for 33
Trials for 3 Groups of Animals.

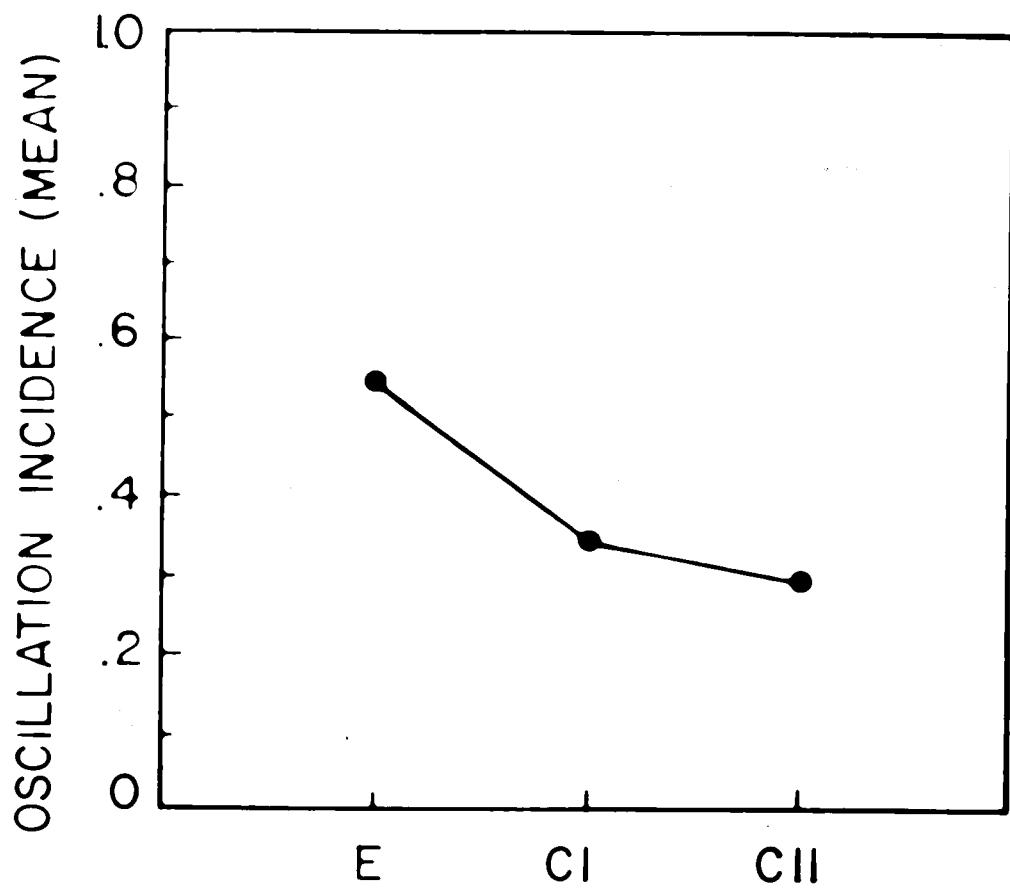
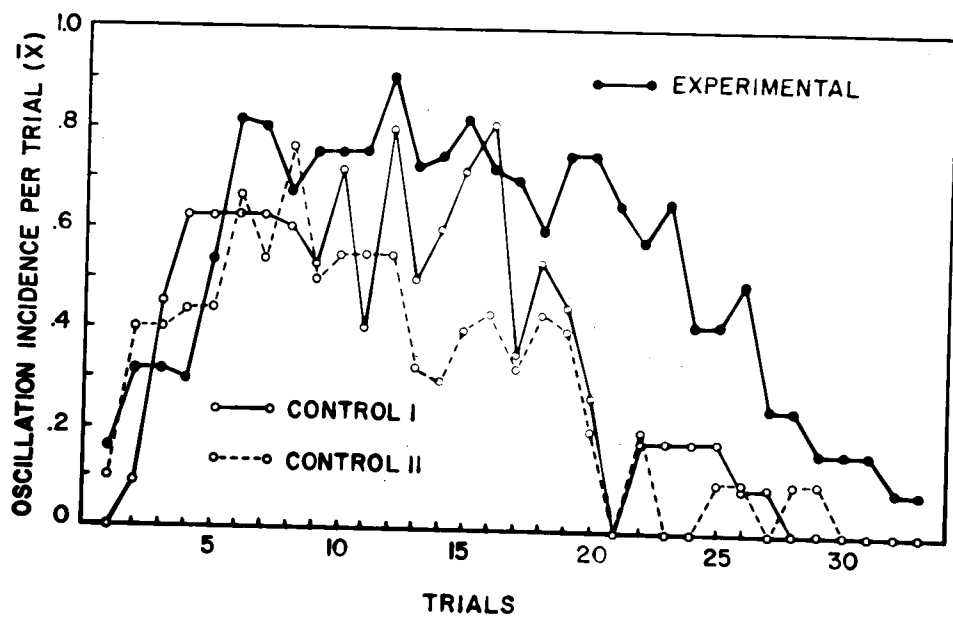


Fig. 11--Mean Number of Oscillation Incidence Per Trial
for 33 Trials for 3 Groups of Animals.



significant $p < 0.001$ was found.

The final measure of behavior was an activity measure using exploratory responses of a pre-determined nature. These behaviors have been used in other studies and are easily observable responses such as raising of the front part of the body, clinging to the wire mesh covering with forepaws, etc. Figure 12 shows the mean incidents of such exploratory responses over the 33 trial period. Evaluation of the results by a χ^2 test shows a significance of $p < 0.001$. Figure 13 summarizes the results of the mean number of exploratory responses per trial in each of the three groups.

Thus, in summarizing the performance of the animals after various treatments of submersion in water at 78°F at weaning age for 1 hour (Experimentals), for 1 minute (Controls I), and for zero minutes (Controls II), it can be said that consistent differences emerged in behaviors observed at adulthood of these animals in an open field test.

Fig. 12--Mean Number of Incidence of Exploratory Responses for 33 Trials for 3 Groups of Animals.

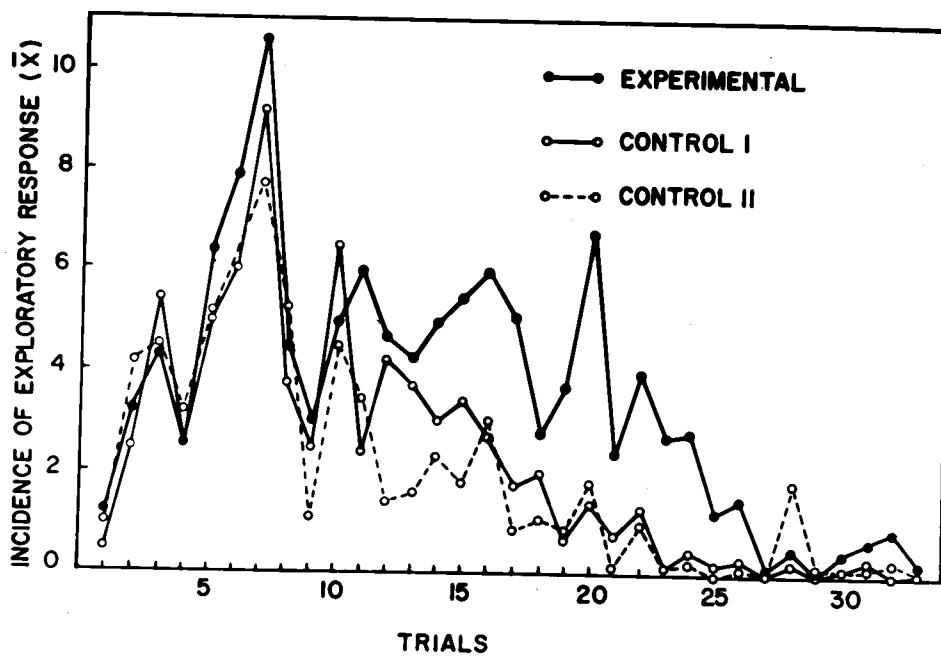
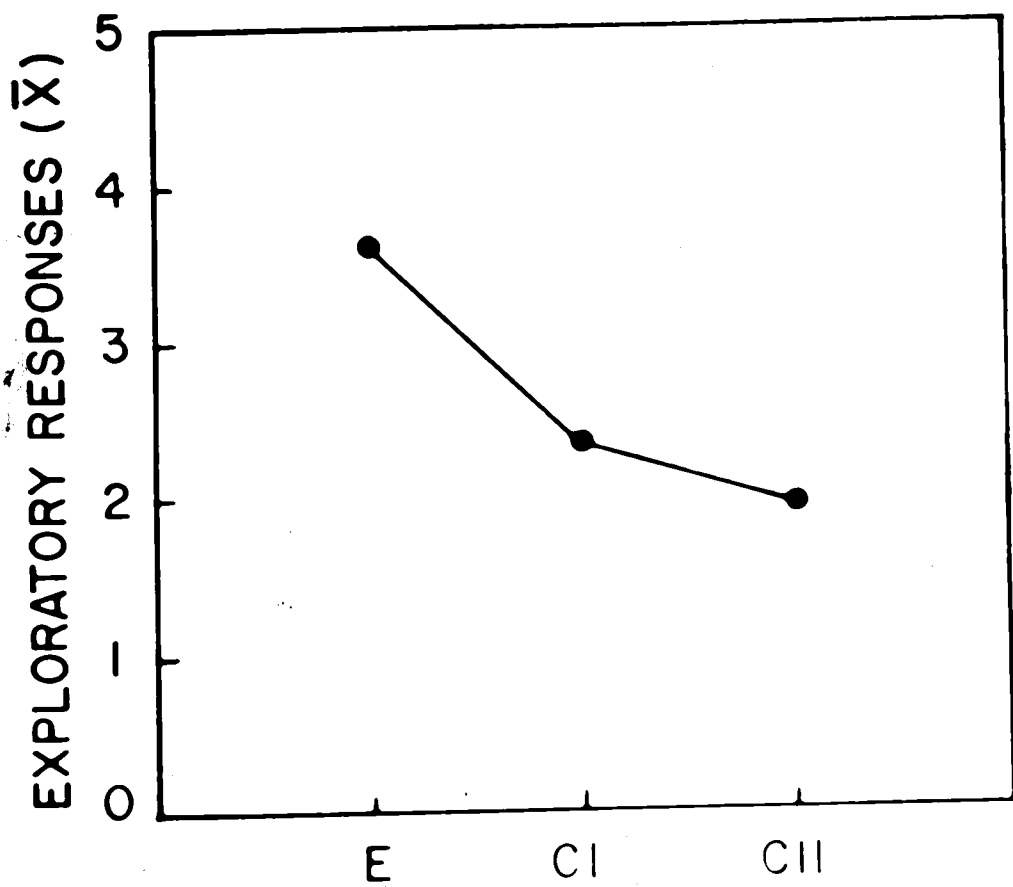


Fig. 13--Mean Number of Exploratory Responses for 33 Trials for 3 Groups of Animals.



CHAPTER V

DISCUSSION

The results of this study provide support for the thesis that an infantile experience produces results which persist into adult life and can be observed in expressions of behavior, activity, and learning situations. Much, if not most of the presently available evidence bearing upon this problem is equivocal and of undetermined reliability because the general belief that early experience does effect later behavior is so often taken for granted. Important areas, as the internal organic characteristics of the organism resulting from a specific form of early experience, have not been investigated systematically. This particular study places most importance on observation of unique behavior differences between the experimental group and control groups which promises further study of specific theories and hypothesis.

Previous experiments done in the particular area of early experience are concerned with a wide variety of topics and the results here not only substantiate some of their findings but broaden the scope of the early experience-later effects model.

In the study by Weininger (1956) it was found that the

experimental rats, (i.e. the ones that had been given disturbing experiences not unlike the animals in the present study), when in an open field ventured significantly close to the brilliantly-lighted center of the open-field setup, thus showing more of a tendency to ignore the natural habit of their species to cling to walls, and to avoid light. In this study the stressed rats also spent more time in the open-field situation. The stressed experimental animals showed more oscillatory behavior when entering the dark enclosed end box and more exploratory behavior than either control group. The initial situation experienced during infancy in these two particular cases seems to be the important factor, whether it be tactile stimulation and gentling or a stressful experience: Therefore, it would appear a reasonable hypothesis that the effects of infantile experience on mature animals' behavior is related to the intensity and kind of early experience.

In Eriksen's study, rats subjected to a series of electroconvulsive shocks between the age of 20 and 30 days suffered permanent impairment of maze-running ability. In this study a similar type of stress also produced significant impairment in learning. In this connection it is of interest to speculate on the distinction between what is conventionally called psychological stress and purely physical stress. It is doubtful that such a distinction can be made in operational terms. All

psychologists would agree that a stimulus (including internal stimuli) must have physical properties to be perceptible. Thus, for example, sound stimuli are conventionally classified as psychological until the upper threshold is reached. Beyond that threshold organic damage will result. However, it is quite interesting to observe that there have been--for obvious reasons, no studies on such an upper threshold. This leaves the division between psychological and physical, at least in the area of auditory stimulation, somewhere in an ill-defined continuum from a few decibels to many hundreds of decibels as for example in aircraft jet noises (270 db). This consideration is mentioned in this context, because it might be argued that the animals in this study were not given a psychological stimulus at weaning but rather were organically damaged, perhaps due to anoxia. First of all, not one of the animals during the time of immersion suffered from lack of air. The nostrils and the mouth of the animals at all times were above water. However, even if the possibility of hyperoxia or anoxia were admitted, it would be most difficult to show that toxic effects of what is conventionally called "purely" psychological stimulation does not similarly result in toxic effects of hormonal hyperdischarge. On the basis of these considerations, it is suggested that the distinction between psychological and physical be treated with caution in such a case as this. Such a distinction implies an impressing

of subjective human judgments upon a situation where such judgments may or may not be warranted. It cannot be stressed enough that the perception of stimuli varies not only within species but very definitely from species to species. In this study, like that of Eriksen's, the stressed experimental group was inferior in performance to the two control groups in a criterion set up for learning in an open field situation.

In the arbitrary criterion of three consecutive direct crossings, an inversion of the Control II and Control I groups was noted and the results here did not follow the trend found throughout the rest of the study. These findings are similar to those of Selye (1950), who investigated the effects of varying degrees of many physiological stresses on the organism. He has employed such stresses as extreme variation in temperature and intravenous injections of glucose and typhoid toxoid into animals. Charts of his data show for each stress an initial dip in the curve in the direction of a final collapse, which is the alarm reaction. It is followed by a rise of the curve above the level normally maintained by the organism, which constitutes a sort of overcompensation or overdefensiveness. As the stress is increased, more and more defenses are called into play until finally no additional ones are available and the system collapses suddenly into death. These data appear to elicit response curves similar to those of Selye. Figure 7 shows the

mean number of trials to criterion of the three groups, and is a measure of learning in this study. The Experimental group, who experienced 60 minutes of the stress situation, took 25 trials to reach the criterion on the average and the Control II group, who experienced nothing unusual, took 20 trials to reach the criterion. But the Control I group, who experienced only 60 seconds of the stress situation, took the least number of trials to reach the criterion, 16. This conforms with Selye's notion that while extreme stress always worsens performance, moderate stress can improve it above the ordinary level.

Another important area to consider is the critical periods during infancy when these experiences are initiated. It has been said to exist between early pre-weaning days to up to 30 days of age. The amount of time that should elapse between these infantile stages of experience and the tests is also important. Some authors find that after the Ss reach an age of 74 days, the differences between groups of rats disappears. The tests were given in this study between 72 and 82 days of age. Either parallel retests or other groups should be tested perhaps as late as 5 to 6 months of age in order to determine more exact results.

A final point to consider is the type of tests to use during adulthood to detect possible effects of early stimulation. More sensitive measures should be developed and specific areas more extensively looked into.

CHAPTER VI

SUMMARY

An experiment was designed to test experimentally whether an intense stressful situation experienced during infancy would have a measurable effect on adult behavior of rats. Thirty-three subjects were randomly divided into three groups; Control II group as the control group without stress; Control I group experiencing a slight stress, 1 minute immersion in water of 78°F; and the Experimental group experiencing an intense stress situation, 60 minutes immersion in water of 78°F. As adults the Ss were tested in a modified Hebb-Williams open field apparatus for 33 trials over a period of ten days. Eight measures of behavior were recorded.

It was found that (1) the amount of time spent in a open field situation differentiates between Experimental and Control group animals, (2) the number of indirect crossings made by the Experimental and two Control groups was statistically different at a $p < 0.05$, (3) after establishing a criterion used as a speed of learning by three consecutive direct crossings, a significant difference was found between the Experimental group

and Control I group of $0.002 > p < 0.02$, (4) oscillatory behavior and incidence of oscillation showed a significantly high consistency of performance by the experimental group, $p < 0.001$, (5) exploratory responses as an activity measure also showed a significant difference between groups of a $p < 0.001$.

The value of observing these behaviors and the emphasis of infantile experience on later behavior were discussed.

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APPROVAL SHEET

The thesis submitted by Betty Lou Penhale has been read and approved by three members of the Department of Psychology.

The final copies have been examined by the director of the thesis and the signature which appears below verifies the fact that any necessary changes have been incorporated, and that the thesis is now given final approval with reference to content, form, and mechanical accuracy.

The thesis is therefore accepted in partial fulfillment of the requirements for the Degree of Master of Arts.

May 26, 1960

Date

Helmut H. Schaefer

Signature of Adviser